

Features

- Universal input mains range: 90 to 264 Vac - frequency 45 to 65 Hz
- Output voltage: 12 V at 12.5 A continuous operation
- Mains harmonics: acc. to EN61000-3-2 class-D or JEITA-MITI class-D
- Standby mains consumption: <0.2 W at 230 Vac
- Efficiency at nominal load: better than 91% at 115 Vac
- EMI: according to EN55022-class-B
- Safety: according to EN60950
- Dimensions: 65x154 mm, 28 mm component maximum height
- PCB: double side, 70 μ m, FR-4, mixed PTH/SMT

Description

The EVL150W-ADP-SR demonstration board is composed of two stages: a front-end PFC using the L6563H and an LLC resonant converter based on the L6599A and the SRK2000, controlling the SR MOSFETs on the secondary side. The SR driver and the rectifier MOSFETs are mounted on a daughterboard.

The characteristics of this design are the very high efficiency and the low consumption at light load which make it a viable solution for applications compliant with ENERGY STAR® eligibility criteria (EPA rev. 5.0 COMPUTER and EPA rev. 2.0 EPS). One of the key factors to achieve high efficiency at heavy load is the SRK2000. This synchronous rectification (SR) driver for LLC resonant converters allows a significant decrease of secondary side losses.

Standby consumption is at a lowest thanks to the sleep-in function embedded in the SRK2000 and the high voltage startup circuit integrated in the

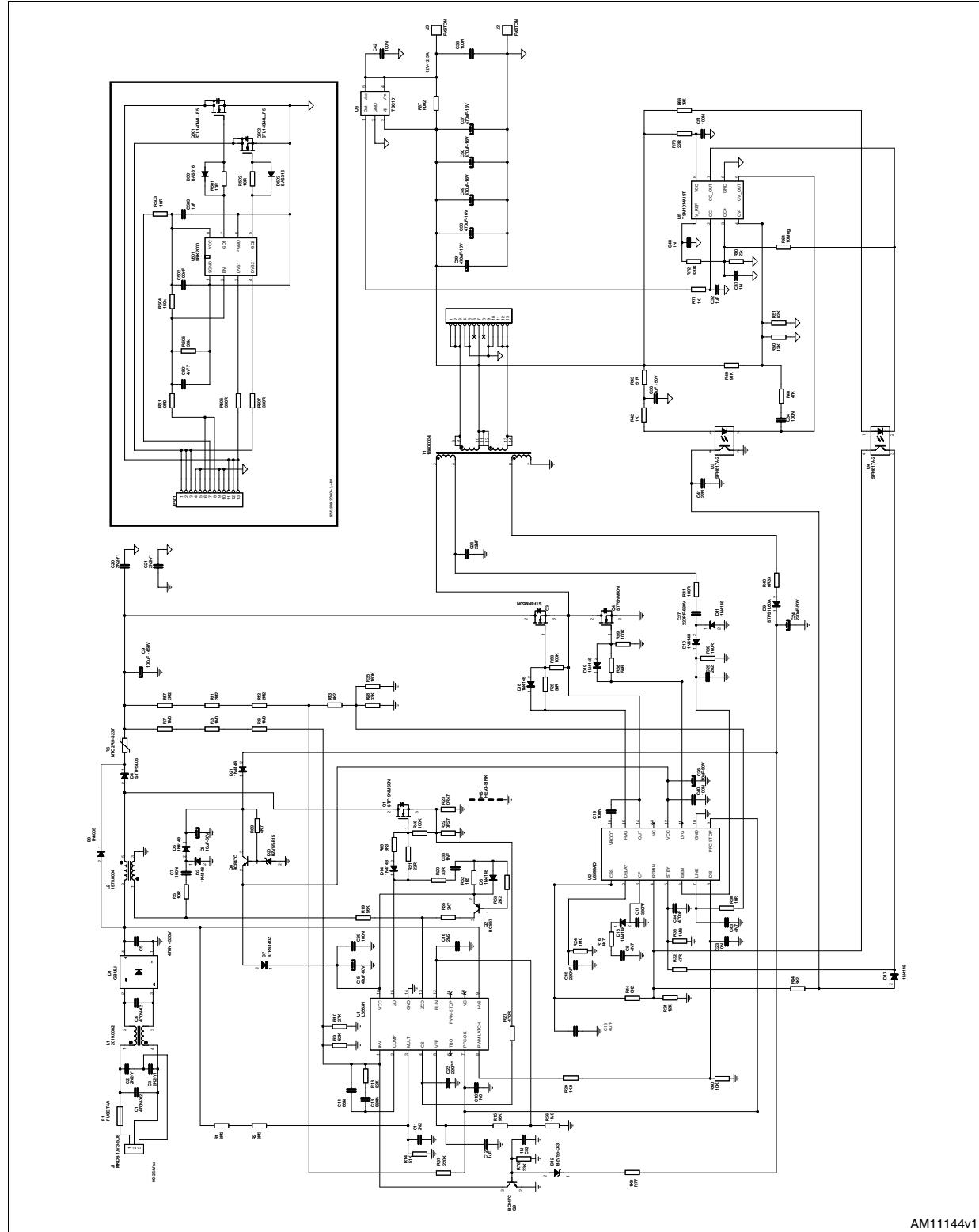


L6563H. The possibility of driving the PFC burst mode via the L6599A PFC_STOP pin dramatically boosts light load efficiency.

Additionally, a secondary sensing circuit dedicated to driving into burst mode the primary controller reduces deviation of light load efficiency against resonant circuit parameter spread, improving the repeatability of the design in production volumes.

1 Electrical diagram

Figure 1. Electrical diagram



AM11144v1

2 Efficiency measurement

EPA rev. 2.0 external power supply compliance verification

[Table 1](#) shows the no load consumption and the overall efficiency, measured at the nominal mains voltages. At 115 Vac the average efficiency is 90.6%, while at 230 Vac it is 91.8%. Both values are much higher than the 87% required by EPA rev2.0 external power supply (EPS) limits.

The efficiency at nominal load, 230 Vac is 94% which is a very high efficiency for a double stage converter and confirms the benefit of the implemented SR.

Also at no load the board performance is superior: maximum no load consumption at nominal mains voltage is 200 mW; this value is significantly lower than the 500 mW limit imposed by the ENERGY STAR® program.

Table 1. Overall efficiency

Test	230 V-50 Hz					115 V-60 Hz				
	Vout [V]	Iout [A]	Pout [W]	Pin [W]	Eff. [%]	Vout [V]	Iout [A]	Pout [W]	Pin [W]	Eff. [%]
No load	12.10	0.00	0.00	0.20		12.10	0.00	0.00	0.20	
25% load eff.	12.14	3.10	37.63	43.15	87.2%	12.13	3.10	37.60	43.08	87.3%
50% load eff.	12.14	6.19	75.15	81.30	92.4%	12.12	6.19	75.02	82.34	91.1%
75% load eff.	12.08	9.37	113.19	120.81	93.7%	12.07	9.38	113.22	123.00	92.0%
100% load eff.	12.04	12.47	150.14	159.79	94.0%	12.04	12.50	150.50	163.90	91.8%
Average eff.				91.8%						90.6%

Light load operation efficiency

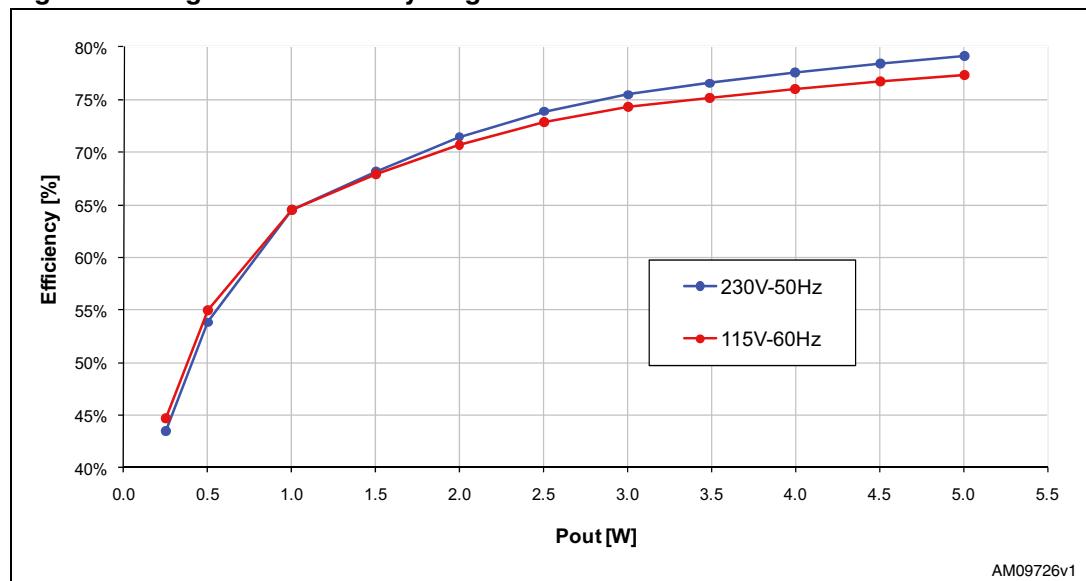
Measurement results are reported in [Table 2](#) and plotted in [Figure 2](#). As seen, efficiency is better than 50% even for very light load such as 500 mW.

Table 2. Light load efficiency

Test	230 V - 50 Hz					115 V - 60 Hz				
	Vout [V]	Iout [mA]	Pout [W]	Pin [W]	Eff. [%]	Vout [V]	Iout [mA]	Pout [W]	Pin [W]	Eff. [%]
0.25 W	12.12	20.84	0.253	0.581	43.5%	12.12	20.84	0.253	0.565	44.7%
0.5 W	12.12	41.34	0.501	0.931	53.8%	12.12	41.34	0.501	0.912	55.0%
1.0 W	12.12	82.65	1.002	1.553	64.5%	12.12	82.65	1.002	1.552	64.5%

Table 2. Light load efficiency (continued)

Test	230 V - 50 Hz					115 V - 60 Hz				
	Vout [V]	Iout [mA]	Pout [W]	Pin [W]	Eff. [%]	Vout [V]	Iout [mA]	Pout [W]	Pin [W]	Eff. [%]
1.5 W	12.12	123.93	1.502	2.203	68.2%	12.12	123.93	1.502	2.211	67.9%
2.0 W	12.12	164.93	1.999	2.797	71.5%	12.12	164.93	1.999	2.828	70.7%
2.5 W	12.12	206.75	2.506	3.392	73.9%	12.12	206.75	2.506	3.439	72.9%
3.0 W	12.11	248.00	3.003	3.979	75.5%	12.11	248.00	3.003	4.040	74.3%
3.5 W	12.11	288.25	3.491	4.560	76.6%	12.11	288.25	3.491	4.644	75.2%
4.0 W	12.11	330.06	3.997	5.155	77.5%	12.11	330.06	3.997	5.258	76.0%
4.5 W	12.11	372.31	4.509	5.748	78.4%	12.11	372.31	4.509	5.874	76.8%
5.0 W	12.11	413.34	5.006	6.327	79.1%	12.11	413.34	5.006	6.474	77.3%

Figure 2. Light load efficiency diagram

3 Bill of materials

Table 3. EVL150W-ADP-SR demonstration board: motherboard bill of material

Des.	Part type/ part value	Description	Supplier	Case
C1	470 nF	X2 - film cap - B32922C3474K	EPCOS	9.0 x 18.0 p15 mm
C2	2.2 nF	Y1 safety cap. DE1E3KX222M	muRata	p10 mm
C3	2.2 nF	Y1 safety cap. DE1E3KX222M	muRata	p10 mm
C4	470 nF	X2 - film cap - B32922C3474K	EPCOS	9.0 x 18.0 p15 mm
C5	470 nF	520 V - film cap - B32673Z5474K	EPCOS	7.0 x 26.5 p22.5 mm
C6	4.7 nF	50 V cercap - general purpose	AVX	0805
C7	100 nF	100 V cercap - general purpose	AVX	PTH
C8	10 μ F - 50 V	Aluminium elcap - YXF series - 105 °C	RUBYCON	DIA 5.0 x 11 p2 mm
C9	100 μ F - 450 V	Aluminium elcap - UPZ2W101MHD	NICHICON	DIA 18 x 32 mm
C10	1 nF	50 V cercap - general purpose	AVX	0805
C11	2.2 nF	50 V cercap - general purpose	AVX	0805
C12	1 μ F	25 V cercap - general purpose	AVX	0805
C13	680 nF	25 V cercap - general purpose	AVX	1206
C14	68 nF	50 V cercap - general purpose	AVX	0805
C15	47 μ F - 50 V	Aluminium elcap - YXF series - 105 °C	RUBYCON	DIA 6.3 x 11 p2.5 mm
C16	2.2 nF	50 V cercap - general purpose	AVX	1206
C17	330 pF	50 V - 5% - C0G - cercap	AVX	0805
C18	4.7 μ F	25 V cercap - general purpose	muRata	1206
C19	100 nF	50 V cercap - general purpose	AVX	1206
C20	2.2 nF	Y1 safety cap. DE1E3KX7222M	muRata	p10 mm
C21	2.2 nF	Y1 safety cap. DE1E3KX222M	muRata	p10 mm
C22	220 pF	50 V cercap - general purpose	AVX	0805
C23	10 nF	50 V cercap - general purpose	AVX	0805
C24	220 μ F - 50 V	Aluminium elcap - YXF series - 105 °C	RUBYCON	DIA10 x 16 p5 mm
C25	2.2 μ F	50 V cercap - general purpose	AVX	0805
C26	10 μ F - 50 V	Aluminium elcap - YXF series - 105 °C	RUBYCON	DIA 5.0 x 11 p2 mm
C27	220 pF - 630 V	630 V cercap - GRM31A7U2J220JW31	muRata	1206

Table 3. EVL150W-ADP-SR demonstration board: motherboard bill of material (continued)

Des.	Part type/ part value	Description	Supplier	Case
C28	22 nF	1 kV - film cap - B32652A223K	EPCOS	5.0 x 18.0 p15 mm
C29	470 µF - 16 V	16 V aluminium solid capacitor	SANYO	DIA 10 X 13 p5 mm
C30	470 µF - 16 V	16 V aluminium solid capacitor	SANYO	DIA 10 x 13 p5 mm
C32	1 µF	50 V cercap - general purpose	AVX	0805
C33	1 nF	50 V cercap - general purpose	AVX	0805
C34	100 nF	50 V cercap - general purpose	AVX	0805
C36	1 µF - 50 V	50 V cercap - general purpose	AVX	1206
C37	470 µF - 16 V	16 V aluminium solid capacitor	SANYO	DIA 10 x 13 p5 mm
C38	100 nF	50 V cercap - general purpose	AVX	0805
C39	100 nF	50 V cercap - general purpose	AVX	0805
C40	100 nF	50 V cercap - general purpose	AVX	1206
C41	22 nF	50 V cercap - general purpose	AVX	0805
C42	100 nF	50 V cercap - general purpose	AVX	0805
C43	4.7 nF	50 V cercap - general purpose	AVX	0805
C44	3.3 nF	50 V cercap - general purpose	AVX	0805
C45	220 nF	25 V cercap - general purpose	AVX	0805
C47	1 nF	50 V cercap - general purpose	AVX	0805
C48	1 nF	50 V cercap - general purpose	AVX	0805
C49	470 µF	16 V aluminium solid capacitor	SANYO	DIA 10 x 13 p5 mm
C50	470 µF	16 V aluminium solid capacitor	SANYO	DIA 10 x 13 p5 mm
C51	100 nF	50 V cercap - general purpose	AVX	0805
C52	1 nF	25 V cercap - general purpose	AVX	0805
D1	GBU8J	Single-phase bridge rectifier	VISHAY	STYLE GBU
D2	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D3	1N4005	General purpose rectifier	VISHAY	DO-41 DO - 41
D4	STTH5L06	Ultrafast high voltage rectifier	STMICROELECTRONICS	DO-201
D5	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D6	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D7	STPS140Z	Power Schottky rectifier	STMICROELECTRONICS	SOD-123
D9	STPS1L60A	Power Schottky diode	STMICROELECTRONICS	SMA
D10	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D11	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80

Table 3. EVL150W-ADP-SR demonstration board: motherboard bill of material (continued)

Des.	Part type/ part value	Description	Supplier	Case
D12	BZV55-C43	Zener diode	VISHAY	MINIMELF SOD-80
D14	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D16	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D17	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D18	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D19	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
D20	BZV55-B15	Zener diode	VISHAY	MINIMELF SOD-80
D21	LL4148	High speed signal diode	VISHAY	MINIMELF SOD-80
F1	FUSE T4A	Fuse 4 A - time lag - 3921400	Littlefuse	8.5x4 p.5.08mm
HS1	HEATSINK	Heatsink for D1, Q1, Q3, Q4		DWG
J1	MKDS 1,5/ 3-5,08	Pcb term. block, screw conn., pitch 5 mm - 3 W.	PHOENIX CONTACT	DWG
J2	FASTON	Faston - connector		DWG
J3	FASTON	Faston - connector		DWG
L1	2019.0002	Common mode choke - EMI filter	MAGNETICA	DWG
L2	1975.0004	PFC inductor - 0.31 mH - PQ26/25	MAGNETICA	DWG
Q1	STF19NM50N	N-channel Power MOSFET	STMicroelectronics	TO-220FP
Q2	BC857	PNP small signal BJT	VISHAY	SOT-23
Q3	STF8NM50N	N-channel Power MOSFET	STMicroelectronics	TO-220FP
Q4	STF8NM50N	N-channel Power MOSFET	STMicroelectronics	TO-220FP
Q8	BC847C	NPN small signal BJT	VISHAY	SOT-23
Q9	BC847C	NPN small signal BJT	VISHAY	SOT-23
R1	3.3 MΩ	SMD standard film res - 1/4 W - 5% - 250 ppm/°C	VISHAY	1206
R2	3.3 MΩ	SMD standard film res - 1/4 W - 5% - 250 ppm/°C	VISHAY	1206
R3	1 MΩ	SMD standard film res - 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R5	10 Ω	SMD standard film res - 1/4 W - 5% - 250 ppm/°C	VISHAY	1206
R6	NTC 2R5-S237	NTC resistor P/N B57237S0259M000	EPCOS	DWG
R7	1 MΩ	SMD standard film res - 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R8	1 MΩ	SMD 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R9	62 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805

Table 3. EVL150W-ADP-SR demonstration board: motherboard bill of material (continued)

Des.	Part type/ part value	Description	Supplier	Case
R10	27 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R11	2.2 MΩ	SMD standard film res - 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R12	2.2 MΩ	SMD standard film res - 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R13	8.2 kΩ	SMD standard film res - 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R14	51 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R15	56 kΩ	SMD standard film res - 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R16	4.7 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R17	2.2 MΩ	SMD standard film res - 1/4 W - 1% - 100 ppm/°C	VISHAY	1206
R18	82 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R19	56 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R20	33 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R21	22 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R22	0.27 Ω	SFR25 axial stand. film res - 0.4 W - 5% - 250 ppm/°C	VISHAY	PTH
R23	0.47 Ω	SFR25 axial stand. film res - 0.4 W - 5% - 250 ppm/°C	VISHAY	PTH
R24	1 MΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R25	56 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R26	1 MΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R27	470 Ω	SMD standard film res - 1/4 W - 5% - 250 ppm/°C	VISHAY	1206
R28	33 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R29	1 kΩ	SMD standard film res - 1/4 W - 5% - 250 ppm/°C	VISHAY	1206

Table 3. EVL150W-ADP-SR demonstration board: motherboard bill of material (continued)

Des.	Part type/ part value	Description	Supplier	Case
R30	10 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R31	12 k Ω	SMD standard film res - 1/8 W - 1% - 100 ppm/ $^{\circ}$ C	VISHAY	0805
R32	47 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R34	27 k Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R35	180 k Ω	SMD standard film res - 1/8 W - 1% - 100 ppm/ $^{\circ}$ C	VISHAY	0805
R36	1.8 M Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R37	220 k Ω	SMD standard film res - 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	1206
R38	56 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R39	160 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R40	33 Ω	SMD standard film res - 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	1206
R41	100 Ω	SFR25 axial stand. film res - 0.4 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	PTH
R42	1 k Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R43	51 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R44	6.2 k Ω	SMD standard film res - 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	1206
R45	3.3 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R46	100 k Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R48	47 k Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R49	91 k Ω	SMD standard film res - 1/4 W - 1% - 100 ppm/ $^{\circ}$ C	VISHAY	1206
R50	12 k Ω	SMD standard film res - 1/8 W - 1% - 100 ppm/ $^{\circ}$ C	VISHAY	0805
R51	82 k Ω	SMD standard film res - 1/8 W - 1% - 100 ppm/ $^{\circ}$ C	VISHAY	0805

Table 3. EVL150W-ADP-SR demonstration board: motherboard bill of material (continued)

Des.	Part type/ part value	Description	Supplier	Case
R52	1.5 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R53	2.2 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R54	0 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R55	2.7 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R57	R002	SMD shunt resistor - RL3264-9 V-R002-FNH-11	Cyntec	2512
R58	100 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R59	100 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R60	10 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R63	0 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R64	10 MΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R68	39 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R69	4.7 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R70	22 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R71	1 kΩ	SMD standard film res - 1/4 W - 5% - 250 ppm/°C	VISHAY	1206
R72	330 kΩ	SMD standard film res - 1/8 W - 1% - 100 ppm/°C	VISHAY	0805
R73	22 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R75	0 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R76	33 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
R77	1 kΩ	SMD standard film res - 1/8 W - 5% - 250 ppm/°C	VISHAY	0805
T1	1860.0034	Resonant power transformer	MAGNETICA	ETD34
U1	L6563H	High voltage startup TM PFC controller	STMicroelectronics	SO-16

Table 3. EVL150W-ADP-SR demonstration board: motherboard bill of material (continued)

Des.	Part type/ part value	Description	Supplier	Case
U2	L6599AD	Improved HV resonant controller	STMicroelectronics	SO-16
U3	SFH617A-2	Optocoupler	Infineon	DIP-4 - 10.16 mm
U4	SFH617A-2	Optocoupler	Infineon	DIP-4 - 10.16 mm
U5	TSM1014AIST	Low consumption CV/CC controller	STMicroelectronics	MINI SO-8
U6	TSC101	High-side current sense amplifier	STMicroelectronics	SOT23-5

Table 4. EVL150W-ADP-SR demonstration board: daughterboard bill of material

Des.	Part type/ part value	Description	Supplier	Case
C501	4.7 nF	50 V cercap - general purpose	VISHAY	0805
C502	100 nF	50 V cercap - general purpose	VISHAY	0805
C503	1 μ F	50 V cercap - general purpose	VISHAY	0805
D501	BAS316	Fast switching signal diode	STMicroelectronics	SOD-123
D502	BAS316	Fast switching signal diode	STMicroelectronics	SOD-123
JP501	Header 13	13-pin connector		
Q501	STK32N4LLF5	N-channel Power MOSFET	STMicroelectronics	POLAR PAK
Q502	STK32N4LLF5	N-channel Power MOSFET	STMicroelectronics	POLAR PAK
R501	10 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R502	10 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R503	10 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R504	150 k Ω	SMD standard film res - 1/8 W - 1% - 100 ppm/ $^{\circ}$ C	VISHAY	0805
R505	33 k Ω	SMD standard film res - 1/8 W - 1% - 100 ppm/ $^{\circ}$ C	VISHAY	0805
R506	330 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
R507	330 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
RX1	0 Ω	SMD standard film res - 1/8 W - 5% - 250 ppm/ $^{\circ}$ C	VISHAY	0805
U501	SRK2000	SR smart driver for LLC resonant converter	STMicroelectronics	SO8

4 Revision history

Table 5. Document revision history

Date	Revision	Changes
25-Jan-2012	1	Initial release.

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY TWO AUTHORIZED ST REPRESENTATIVES, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2012 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com